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Teacher Contact

* **First Name:**	Stephanie
* **Last Name:**	Haas
* **Position/Title:**	Teacher
Phone Number:	(530)894-3952
* **E-mail:**	shaas@corebutte.org

* **Was this course Previously Approved by UC?** No

* **Course Title:**	Conceptual Physics
* **Transcript Title /Abbreviation:**	**Transcript Title /Abbreviation: Course Code** a-g Conceptual Physics
* **Seeking "Honors" Distinction:**	No
* **Subject Area:**	Laboratory Science
* **Category:**	Physics
* **Grade Level for which this course has been designed:**	☑ 9 ☑ 10 ☑ 11 ☐ 12
* **Unit Value:**	1.0 (one year, 2 semesters, or 3 trimesters equiv.)

* **Is this course, or any separate section of this course, taught in an online learning environment:** No

* **Is this course classified as a Career Technical Education:** No

* **Brief Course Description**

This course deals with the principles, concepts, and laws that govern the physical universe that we live in. Students explore the concepts using laboratory experiences to strengthen problem-solving skills and teach basic experimental techniques. Following the scientific method and engineering cycle, students will complete several collaborative investigations and projects that are at the core of this course. Use of the textbook and practice problems help reinforce the concepts being experienced collaboratively in class. The students are introduced to physics through the study of the following: motion, forces, energy and systems, matter and energy, electricity, electricity and magnetism, and waves. Other topics covered in this course include conservation of energy, human impacts on the environment, projectile motion, wind turbines and energy, and atomic structure. This course is designed for the student who wishes to take physics or chemistry, but does not want to pursue a scientific course of study in college. This course will take a hands-on approach to learning physics in our everyday world. The course curriculum will follow the California State Standards to ensure that students have an understanding of the science of physics, but will focus on the concepts and principles and less on the mathematical component. Because of the importance of hands on activities in science, this class will utilize a strong hands-on approach and have a significant number of laboratory activities.

Pre-Requisites

Algebra 1 - Recommended

Co-Requisites

Algebra 1 - Required

Context for Course (optional)

Our school is a charter high school that prepares students who want to attend a college or university. Many of our students want to take Chemistry or Physics to fulfill the UC and CSU requirements, but a number of them do not meet the math requirements for our college preparatory Chemistry class. This class is designed to accommodate those students so they can meet the physical science requirements. It is rigorous physics course, as to give students a strong foundation in the physical sciences without the heavy math requirements. . The course also requires students to engineer various machines, working to design and build them as a team. The students are introduced to the principles, concepts, and laws of our physical universe using laboratory experiences to strengthen problem-solving skills and teach basic experimental techniques.

History of Course Development (optional)

Textbooks

TEXTBOOK 1

* **Title:**	Physics: A First Course
* **Edition:**	2nd
* **Publication Date:**	2012
* **Publisher:**	CPO Science
* **Author(s):**	Tom Hsu, Ph.D.
URL Resource:	http://www.cposcience.com/home/ForEducators/PhysicsAFirstCourse2ndEdition/tabid/481/Default.aspx
* **Usage:**	Primary Text Read in entirety or near entirety

Supplemental Instructional Materials

CPO Science Link Series - Investigation modules and equipments that provide experiments at various skill levels to be used for most investigations throughout the course. The modules being used are: energy car and track system, chemical models, electric circuit, electric motor, marble launcher, wind turbine, and geobox. Physics: A First Course Guided Reading and Practice Worksheets - Used for practice and comprehension at home as homework. Expository Readings - Selected readings used to aid student understanding of key concepts.

* **Course Purpose**

This course deals with the principles, concepts, and laws that govern the physical universe that we live in. Students explore the concepts using laboratory experiences to strengthen problem-solving skills and teach basic experimental techniques. Following the scientific method and engineering cycle, students will complete several collaborative investigations and projects that are at the core of this course. The concepts students learn are applied to real-world situations, machines, and systems. Use of the textbook and practice problems help reinforce the concepts being experienced collaboratively in class. The students are introduced to physics and its applications through the study of the following: motion, forces, energy and systems, matter and energy, electricity, electricity and magnetism, and waves. Other topics covered in this course include conservation of energy, human impacts on the environment, projectile motion, wind turbines and energy, and atomic structure. This course is designed for the

student who wishes to take physics or chemistry, but does not want to pursue a scientific course of study in college. This course will take a hands-on approach to learning physics and its applications in our everyday world. The course curriculum will follow the California State Standards to ensure that students have an understanding of the science of physics, but will focus on the concepts and principles and less on the mathematical component. Because of the importance of hands on activities in science, this class will utilize a strong hands-on approach and have a significant number of laboratory activities.

* **Course Outline**

This course is taught using the CPO Science Physics: A First Course used in conjunction with their modular LINK experimentation kits. Within each unit, students are spending most of the classroom time investigating, discussing, and working collectively, with little time spent in a traditional lecture setting. The investigations are the heart and soul of this course, which is reflected in the course outline below. Unit 1 – Motion- This course begins with an overview of physics as a methodology of science, its purposes, importance, and effect on the daily lives of humans everywhere. In this first unit, the students are exploring and creating their own understanding of motion, both linear and projectile. Students begin by discussing linear motion and its relativity. First, they must understand about lab safety, the scientific process, identifying variables, and units before experimentation. Once they have a strong foundation to build on, a thorough study of speed allows students to be able to distinguish between speed and velocity, and also detect whether velocity is changing. With this understanding, they progress to a study of acceleration. They study acceleration due to gravity (constant acceleration) and its effect on an object in free fall and one thrown straight up. Along with acceleration, they will learn to measure and determine the speed, distance, and time traveled, and students use this data to plot their relationships on graphs. By the end of the chapter, students should be able to make and interpret both position and velocity versus time graphs. Next, students gain an understanding of Newton's Laws of Motion. They begin by learning about inertia by experimenting with changes in mass, volume, and weight. Using inquiry, they attempt to explain how objects that are not touching the Earth keep up with the rotation of the Earth. For Newton's Second Law, students use energy cars on force sensing tracks to experiment with the relationship between acceleration and the net force of a system, along with the relationship between acceleration and mass. To do this, students will observe foam and a rubber balls in free-fall motion and work together to explain why the mass has no effect on an object in free fall. This will demonstrate the connection between gravity and free-falling objects. Lastly students will use the energy cars to demonstrate impulse, momentum, and Newton's Third Law of action and reaction. Energy and the conservation of it are studied, which include an introduction to potential and kinetic energy. With this as an introduction, students then conduct an investigation that will lead them to an understanding of the conservation of energy and momentum during various collisions, both elastic and inelastic. The students' understanding of Newton's Laws aids them in looking at several situations and applying the correct law to them explaining why that law applies and how it works. Completing this unit, the students should have a good understanding of the scientific process, how to describe motion and its laws, and energy and momentum conservation in collisions. Key Assignments and Labs: see "Laboratory Activities" section for Modules 1-3 and "Key

Assignments" section for the Group Project – Unit 1 – Analyze a Collision. Unit 2 - Forces – The unit begins with a study of vectors using forces as examples. Since the math requirement is at a lower level for this course, the students learn to use the Pythagorean theorem to separate force vectors into their components instead of using trigonometric functions. Once they understand vectors, they begin working with free-body force diagrams to draw force systems. The students conduct an inquiry experiment to use the components of a vector to make predictions about the motion of the energy car is it moves along the track. They apply Newton's Second Law to distinguish between predicted and measured values of net force. The study of forces continues by working with forces in equilibrium. Springs and tensile forces are studied, which includes work with Hooke's Law and hanging masses at rest. Next, the students learn about friction by experimenting to determine the force of friction present when the energy car sleds of different masses are launched and move along the track, in order to calculate the coefficient of kinetic friction. Students should comprehend the connection between Newton's laws of motion and equal-opposite forces as the complete their study of friction and forces in equilibrium. With an understanding of forces and friction, students learn about rotational motion and equilibrium. Torque is a primary focus, which the students learn to calculate. With a clear understanding of one-dimensional motion, the unit then progresses into two-dimensional projectile motion. Using marble-launching devices, students will study vectors and its effect on motion. They will manipulate various variables, including initial velocity, angle of motion, and distance traveled, in an inquiry investigation to find the ideal set of conditions for the greatest distance traveled by their marble. Students are expected to model their understanding in a descriptive diagram of their two-dimensional projectile motion explaining how their variables interacted to create the outcome they saw. By the end of the chapter, students will develop many skills, such as adding vectors, calculating values using kinematic equations, working with rotational motion and universal gravitation laws. This will aid them in completing the Unit 2 group project of applying gravitation laws to satellites in orbit. Using the marble launcher, students examine how launch speed affects range as an introduction to circular motion. They will use a bicycle wheel as a model to manipulate circular motion variables and understanding the differences between the concepts of linear, rotational, and rolling motion. Next, students will gain an understanding of centripetal force by investigating the mystery of why water doesn't fall out of a bucket when it is upside down during centripetal motion. They work to apply Newton's second law of motion to find angular acceleration of the system. All of this helps the students explain the phenomenon that is keeping the water in the bucket as it moves over their heads. This final study of forces gives students the strong understanding of forces acting on a system, which will aid them in their investigations of energy in a system in the next unit. Key Assignments and Labs: see "Laboratory Activities" section for Modules 4-6 and "Key Assignments" section for the Group Project – Unit 2 – Apply Gravitational Motion to Satellites. Unit 3 – Energy and Systems – The unit starts with a study of force, work, and machines. Students will start to make sense of these topics by being asked to build a simple machine that multiplies force. This investigation allows students to explore the concepts of mechanical advantage, gear ratios, and levers. With a clear understanding of work, students next explore the relationship of work and energy to create power. The energy cars will be used to experiment in order for students to define work in terms of force, distance, and energy, calculate the work done when moving an object, and explain the relationship between work

and power. Students will be introduced to efficiency and how to calculate it. This is a foundation that students must understand to be able to grasp the concepts of energy next in the unit. With a foundation of work and power, students advance their study to energy, efficiency, and the conservation of energy. First, students will look at energy in a system by using the energy cars and tracks. With this experience, students will be able to explain power in flowing energy. Next, students look at energy and efficiency by experimenting to determine how efficiently energy is changed from one form to another. This will demonstrate the concept of efficiency in use of energy and set up the concept of conservation of energy. In the final experiment of the unit, students design and conduct and experiment to determine what limits how much a system may change in terms of energy. Understanding what limits energy transformation will help them completed the final group project for the unit, where students are challenged to design and build a rollercoaster. They must calculate energy and find a way to release the marble and have it run the whole track without stopping. All of these experiences allow students to master the concepts of energy within physical systems they are exploring. Key Assignments and Labs: see "Laboratory Activities" section for Modules 7-8 and "Key Assignments" section for the Group Project – Unit 3 – Design a Rollercoaster. Unit 4 – Matter and Energy – In this unit, students will learn several topics in our study of chemistry through the eyes of physics, which include the following concepts: matter, temperature and pressure, heat and heat transfer, atomic structure, quantum theory of the atom, nuclear reactions, and the relationship between matter and energy. In the first part of this unit, students learn the basics of matter, temperature and pressure, and heat and heat transfer. Continuing on their previous study of energy, students start the unit by looking at heat energy and transfer. The first investigation has the students discovering the difference between temperature and heat. They are expected to describe the relationship between temperature and heat, apply the heat equation to predict the final temperature of a mixture, and infer that different substances are able to store different amounts of heat. This will help the students distinguish between heat and temperature, so that they may best describe changes in heat energy that they observe. After a discussion about phase changes at the molecular level, students will conduct an investigation to determine how energy is involved when matter changes phase. A critical skill they will gain through this investigation and molecular modeling is reading a heating and cooling curve. They follow up the study of phase changes with an introduction to heat transfer and specific heat. Students will apply their knowledge of heat to study specific heat and it's applications. Students will use an island as a model to describe the heating and cooling of land and water by explaining how solar radiation affects the heating and cooling of continents and oceans. This will allow students to compare geographic regions that have large and small temperature changes. Next, students must learn the basics of matter, including atomic structure and formation of compounds. Students model their understanding of the structure of atoms, pure substances and compounds, chemical formulas, and the periodic table. Students use their models to build simple models of compounds, write their chemical formulas, and explain the meaning of a chemical formula. With this foundation, students learn about valence electrons and chemical bonds. They will model electron arrangements to learn about energy levels, chemical bonds, and the difference between ionic and covalent bonds. This will allow students to develop a strong understanding of how the periodic table is built and the reasoning behind the arrangement of atoms. Lastly, students will use the models to balance chemical equations and

classify chemical reactions. Using the chemical equation, students model simple chemical reactions and balance simple equations. Doing this will allow them to discover the law of conservation of mass. As the last section of study of the chemistry unit, students explore the quantum theory and nuclear reactions. Again, using the models, students will explore quantum theory, how atoms produce light, and the electron's role in that. Students learn how elements produce light, to recognize the difference between an atom at its ground state and an excited state, and explain how electrons are involved in light absorption and emission. With this understanding, they progress to the concept of nuclear reactions. They learn about the structural differences between the structure of stable and unstable atoms. Students will build models of stable and unstable atoms, model an ion and isotope for comparison, and calculate the charge of an ion. Using the models to study both quantum theory and nuclear reactions allows students to apply their prior knowledge of atomic structure to varieties and applications of atoms in reactions. The final application within this unit, is discussing the effects of radiation on humans through a research reports and presentations. Making students aware of the dangers of radioactivity will help them make decisions and opinions about the benefits and risks involved. Key Assignments and Labs: see "Laboratory Activities" section for Modules 9-11 and "Key Assignments" section for the Research Reports – Unit 4 – Effects of Radiation on Humans. Unit 5 – Electricity – In this unit, students will learn about electricity and circuits, which include the following concepts: electric circuits, current and voltage, resistance and Ohm's Law, series and parallel circuits, electrical power, electric charge and current (AC and DC), resistance, voltage, and capacitors. To experiment in this unit, students will use light bulb and resistor electrical circuit set ups to learn these key concepts. Students will go through a variety of investigations in order to master the concepts presented in this unit. The first part of this unit is about electric circuits, current and voltage, and resistance and Ohm's Law. The students will use the light bulb circuits to discover what an electric circuit is. They will build a simple circuit, diagram it, explain how a switch works, identify open and closed circuits, and test conductors and insulators. This experience will help them understanding the electrical current that flows through the circuit. This includes being able to calculate voltage and current at points in the circuit. Finally, they will investigate the ideas of resistance and Ohm's Law, in order to be able to participate in an inquiry activity where students are challenged to answer the question: how are voltage, current, and resistance relate? Students will do this by describing how current changes when resistance and voltage are increased and explaining why resisters are used in a circuit. Once they have experimented and built various circuits, they will have to analyze a circuit to explain why bulbs in a 2-bulb parallel circuit are brighter than ones in a 2-bulb series circuit. In order to do that, students must build series and parallel circuits, analyze the voltage and current and different places in the circuits, and explain why the bulbs wired in parallel are brighter than those in series. Finally, students will complete a group project, using the engineering cycle, to design and build an electric circuit. This will demonstrate their mastery of electrical circuits and give them more practice with their engineering skills. Key Assignments and Labs: see "Laboratory Activities" section for Modules 12-13 and "Key Assignments" section for the Group Project – Unit 5 – Design and Build an Electric Circuit. Unit 6 – Electricity and Magnetism – For this unit, students will use a model wind turbine and electric motor powered by magnets to study the concepts of magnetism and its applications to electricity. During this unit, the students will study the following

concepts: properties of magnets, source of magnetism, Earth's magnetic field, electric currents and magnetism, electric motors, and electric generators and transformers. This unit uses the applied knowledge from the last unit applied to real-life energy using and transforming machines. To begin their study, students will complete investigations about magnets and magnetic materials. They should be able to predict whether two magnets with attract or repel given their alignment and measure the distance at which magnets attract and repel each other. Once they can do this, they will explore materials that are affected by magnets. Students will list examples of materials that are and are not affected by magnets, as well as describe the effect of non-magnetic materials on magnetic forces. Finally, students will use their understanding of electricity and magnets to build an electromagnet, in order to explore the concept that electric current creates a magnetic force and field. With their foundational understanding, students will progress to studying how motors work and building one on their own. First, they must understand how a motor works. Students will conduct an investigation to construct a working motor. Once they have successfully built a motor, they will design motors for various tasks and evaluate all designs and come to a consensus, through scientific argumentation, on which motor will serve the different required tasks best. Going through this process will allow them to understand how a motor works, how to design and build one, and finally how to analyze a motor for effectiveness in completing various tasks. After completion of these tasks, students will wrap up the unit with a look at energy generators and transformers, such as a wind turbine. As the final part of the unit, students will be studying wind power, wind turbines, and how to generate electricity with it that is done in a safe, sustainable way. This lab module will have students learning how to generate electricity from the wind, how to design an efficient, working wind turbine, how human activity impacts the environment in positive and negative ways, what variables affect the movement of the blades on a wind turbine, and finally what variables effect the production of electric current in a wind turbine. Students will go through a process step-by-step where they will learn about the turbines, analyze and evaluate current or proposed turbines, and design and build a working wind turbine for themselves. It is important for students to look at human impacts on the environment and consider these factors when making their decisions. A part of this process is completing a research project on human impacts on the environment. Also, seeing the effects of changing variables, such as blade shape, mass, kinetic energy, coil size, and the number of magnets present, will allow students to develop a strong mental model of how changes in wind turbine design can make their turbines more or less effective and efficient. This unit-culminating activity is one that will leave students with strong ties between their knowledge, engineering skills, and environment. Key Assignments and Labs: see "Laboratory Activities" section for Modules 14-16 and "Key Assignments" section for the Group Project – Unit 6 – Design and Build an Electric Circuit and for the Research Reports – Unit 6 – Human Impacts on the Environment. Unit 7 – Vibrations, Waves, and Sound – In this unit, students will be looking at strings and pipes, as either oscillators or instruments, to learn the properties of vibrations, waves, and sound. This unit will be briefer than the others, as it is more of an overview, rather than a detailed study of all concepts. Students will learn the following concepts: harmonic motion and its graphs, properties of oscillators, the motion of waves, wave interference and energy, properties of sound and sound waves, and sound, perception, and music. As a culminating activity for the unit, the students will be designing and building and instrument with their understanding of these

concepts. In the first part of this unit, students will be studying harmonic motion and the properties of oscillators. To do this, students will work with a pendulum to describe its motion, measure the amplitude and period of it, describe any oscillators in terms of frequency, period, amplitude, and phase, and learn to read and represent these things on a graph. Once students have measure, manipulated, and graphed the variables of an oscillator in harmonic motion, they will explore what kinds of systems oscillate. To apply their knowledge, students will look at harmonic motion in relation to skyscrapers. They will apply their understanding to describe important factors that must be considered when building tall skyscrapers. Finally, they will look at different designs of skyscrapers and analyze them for their safety and effectiveness in withstanding the environmental factors that affect all buildings of that size. Once students understand harmonic motion and oscillators, they are prepared to study waves and their properties. To begin, students will investigate waves and their properties using a string over a small tube of colored water. They will explain how waves move, compare and contrast transverse and longitudinal waves, and use knowledge of these wave types to describe water waves. Next, students will learn about the various waves that surround them on a regular basis. They will then investigate to discovery how to make and control waves. Students will describe how frequency, wavelength, and speed are related, measure the wavelength and frequency of a vibrating string, recognized and apply the concept of harmonics in resonant systems, and define natural frequency and apply methods for changing the natural frequency of a system. In a final investigation before studying sound, students will determine how changing the tension of a vibrating string affects it. They will apply an understanding of inertia and restoring force to describe the effects of increasing the tension of a vibrating string. This will be a great transition topic for students as we move into the study of sound and their final project. In order for students to build an instrument, they must understand the concepts of sound, hearing, and music. To reach this point, students will begin by investigating what sound is and how we hear it. They will identify a range of frequencies humans can hear, describe how perception influences the sound humans hear, and make and analyze a histogram of class data. Next students will experiment to determine whether sound behaves like other waves and how interference is also evidence of the wave nature of sound. Lastly, they will investigate how we observe sound as a wave and how we can use the speed of sound and certain frequencies to build a basic instrument based on wavelength. Students will use this experience to produce their own individual instruments. They can be either a string or pipe/wind instrument. It must be different from the one we make as a class during class time. This will be the concluding experiment and project, which will require great application of all physics knowledge and skills gained in this unit and throughout the course. Key Assignments and Labs: see "Laboratory Activities" section for Modules 17-19 and "Key Assignments" section for the Group Project – Unit 7 – Design and Build a Musical Instrument.

* **Laboratory Activities**

Throughout this course, the students will complete lab work in modules by utilizing high-quality scientific laboratory equipment modules to complete their investigations. Lab activities occur regularly and can occupy up to half of the given in-class time within a week, giving students apple time to inquire, hypothesize, observe, experiment, and rationalize various situational studies.

Each unit has 1-3 lab modules with in, in order to allow students to connect ideas in each unit. This is more effective than separate labs where students complete the work but fail to connect their experiences through a series of labs. Within each module, students conduct multiple experiments to better grasp the main concepts they are studying, in the text and classroom activities, and how they apply to real-life situations. Students must complete at least 1 formal lab write up for each unit to demonstrate their mastery of concepts and skills associated with this topic. Unit 1 – Motion Module 1 In the first part of their laboratory experimentation, students will begin their study by understanding how they design a valid experiment. They will use energy cars on tracks with data collectors equipped with photo gates and stopwatches to measure and calculate time, speed, and acceleration. Students will be learning to identify and discuss variables in terms of experimentation. They will learn to set up an experiment, explain the difference between experimental variables, and discuss why conducting multiple experimental trials is better than gathering only one set of data. Students will be using premade lab write-ups during this module, in order for students to focus on skills of data collection and hypothesis formation. During the next module, they will advance their lab-write up skills further. This will be a critical foundation for their future lab work. Module 2 Students use the energy cars and tracks to work to measure time accurately and predict the speed of the car as it moves down the track. These sets of experiments seek to teach the students to accurately measure time, predict what happens to the car's speed as it travels down the track, create and interpret a speed vs. position graph, use a graph to make a prediction that can be quantitatively tested, and calculate the percent error between a measurement and a prediction. The concept of experimental error is introduced and thoroughly discussed with use of the ideas of accuracy, precision, and sources of experimental error. In the second experiment in this module, student knowledge is advanced using the energy cars to discover the acceleration of the cars. They are expected to define acceleration, analyze position versus time graphs to explain changes in motion, and apply the acceleration formation to solve problems. Using the energy cars, the students are able to grasp the foundation of motion, how to describe it, and what the variables and measurements are and demonstrate. As a part of this module, students will write their first complete lab report including all parts of a traditional lab report given in a template. It will be handwritten on a template to model for students what is expected. In the next module, they will type a formal lab report for submission and evaluation. Module 3 Students continue their use of the energy car and track to study Newton's three laws of motion. Their first investigation uses guided inquiry to help answer the question: what is the relationship between force and motion? The students are expected to develop a hypothesis and procedure to complete the following tasks: use the cars to describe how a net force impacts motion, explain the meaning of acceleration, and use observations to interpret Newton's first and second laws of motion. During the second investigation, students observe what happens when equal and opposite forces are exerted on a pair of energy cars. This will enable students to be able to explain the meaning of action-reaction forces discussed in Newton's third law. Students will apply knowledge of Newton's first and second laws to explain the resulting force when objects experience equal and opposite forces, as well as observe examples of Newton's third law. As part of the write-up, they are expected to draw labeled model diagrams of the system including all forces acting on it. As a class, they will share and critique their models to develop a whole-class, consensus model of what is happening in the system. This exercise

encourages respectful scientific argumentation and discourse, which is an essential scientific skill to develop. Lastly, students will do an inquiry investigation to determine why things bounce back when they collide. This will help them explain what happens when objects collide in terms of Newton's third law and apply the law of conservation of momentum when describing the motion of colliding objects. For this experiment, the students will be writing and typing a formal lab report without help from a preprinted template. They will be discussing and hypothesizing in groups before work begins, determining the procedures, collecting and analyzing data, and reporting their findings as part of their work using the scientific method. All of these experiments focus on inquiry and student-centered experimentation. They help to connect all the parts of motion they studied earlier in the unit. Unit 2 – Forces Module 4 Continuing the use of the energy cars and tracks, students begin this lab module by conducting an inquiry experiment to use the components of a vector to make predictions about the motion of the energy car as it moves along the track. Using the vector-resolving skills they developed before this investigation, students will diagram their predicted system and use them to calculate their predictions. Then they will apply Newton's Second Law to distinguish between predicted and measure values of net force. Again, experimental error will be highlighted, calculated, and discussed for reinforcement. Next, students will launch energy cars of different masses down the track recording the time through the photo gate for each launch. This information will be used to calculate the speed, in order to look at the relationship between speed and mass. Then the students will do the same experiment by starting the car at a constant height, in order to further see the relationship between mass and speed. After gathering the data and doing the calculations, students discuss the relationship between mass and speed, comparing and contrasting the ideas of inertia, weight, and mass. Module 5 The study of forces continues by working with forces in equilibrium. Departing from the energy car and track, students will experiment with springs and strings with masses and the laws that govern them. Springs and tensile forces are studied through work with Hooke's Law and hanging masses at rest. Students are expected to understand forces in two directions and restorative force, which will include work resolving forces and velocities into their vector components. This will lead students into the study of energy in the next unit and a better understanding of the forces present in simple harmonic motion. Following this study, students will determine the force of friction present when the energy car sleds of different masses are launched and move along the track, in order to calculate the coefficient of kinetic friction. They will begin with drawing a prediction model and a final experimental model for comparison. Then students must observe the effects of air, rolling, and sliding friction and compare the effects of those on an object's motion. They must modify their original models to include all possible forms of friction. They will discuss and share their models, which will help them build a class consensus model of the system. All of this differentiation allows students to build a strong mental model of friction and frictional forces in physical systems. Lastly, they will study torque as a part of rotational motion. In order to do this, they will be using a yardstick as a balance lever to show the effect of different masses at different distances from the axis on the torque of the system. They will further apply their knowledge to the wheel and axel systems of the energy cars they have been working with. The goals are that the students analyze the relationship between forces and torques and their role in systems in equilibrium, as well as the role of forces and torque in levers and wheel and axels systems of the energy cars. The students will be writing an

informal lab write up for this lab for assessment, which must include a labeled model of the torque being experienced by the energy car wheel and axel. Module 6 With a clear understanding of one-dimensional motion, the unit then progresses into projectile motion. Using marble-launching devices, students will study vectors and its effect on motion. They will manipulate various variables, including initial velocity, angle of motion, and distance traveled, in an inquiry investigation to find the ideal set of conditions for the greatest distance traveled by their marble. Students are expected to model their understanding in a descriptive model diagram of their two-dimensional projectile motion explaining how their variables interacted to create the outcome they saw. Using the marble launcher, students examine how launch speed affects range as an introduction to circular motion. Next, students will use a bicycle wheel as a model to manipulate circular motion variables and understanding the differences between the concepts of linear, rotational, and rolling motion. The will experiment to gain an understanding of centripetal force by investigating the mystery of why water doesn't fall out of a bucket when it is upside down during centripetal motion. This is a common phenomena not understood by students. They will use the photo gates to measure time of rotation, as to study the angular speed. With this, the students work to apply Newton's second law of motion to find angular acceleration of the system. All of this helps the students understand the force that is keeping the water in the bucket as it moves over their heads. The students will be required to complete a formal lab report for this investigation. This final study of forces gives students the strong understanding of forces acting on a system, which will aid them in their investigations of energy in a system in the next unit. Unit 3 – Energy and Systems Module 7 The unit starts with a study of force, work, and machines. Students will start to make sense of these topics by being asked to build a simple machine that multiplies force. They are given a variety of materials and asked to measure and compare input and output forces and distances for different machine setups, and further they must calculate and compare work input and work output. The challenge for the lab is to be the group that builds the machine that multiplies the most force. With a clear understanding of work, students next explore the relationship of work and energy to create power. The energy cars will be used to gather force and distance data as the move along the track to create graphs, which are used through analysis to calculate work. Doing analysis on this data will allow the students to see the relationship between the work done by a force and the energy of a body. Students will also derive the formula for the speed of a car from force and mass data. This is a foundation that students must understand to be able to grasp the concepts of energy next in the unit. Module 8 With a foundation of work and power, students advance their study to energy, efficiency, and the conservation of energy. First, students will look at energy in a system by using the energy cars and tracks. They will work to understand how energy is related to motion by discussing the meaning of a system, describing the motion of the energy car in terms of energy, and inferring the objects possess either energy due to their position or energy due to their motion. With this understanding, students look at energy and efficiency by experimenting to determine how well energy is changed from one form to another. The students do this by comparing the energy of an object before and after being accelerated by a rubber band to determine the efficiency of energy transfer. This will demonstrate the concept of efficiency in use of energy and set up the concept of conservation of energy. In the final experiment of the unit, students design and conduct and experiment to determine what limits how much a system may

change in terms of energy. They will analyze a speed versus height graph, calculate potential energy, and use energy conservation to derive a formula for the speed of the car in terms of energy. Students are required to complete a formal lab report for their work done in this experiment. All of these experiences allow students to master the concepts of energy within physical systems they are exploring. Unit 4 – Matter and Energy Module 9 In the first part of this unit, students learn the basics of matter, temperature and pressure, and heat and heat transfer. Continuing on their previous study of energy, students start the unit by looking at heat energy and transfer. The first investigation has the students discovering the difference between temperature and heat. They are expected to describe the relationship between temperature and heat, apply the heat equation to predict the final temperature of a mixture, and infer that different substances are able to store different amounts of heat. This will help the students distinguish between heat and temperature, so that they may best describe changes in heat energy that they observe. After a discussion about phase changes at the molecular level, students will conduct an investigation to determine how energy is involved when matter changes phase. Students will compare and contrast properties of matter in the solid, liquid, and gas phases, as well as describe what happens, in terms of energy, when matter changes phases. They follow up the study of phase change with an introduction to heat transfer and specific heat. Lastly, students will apply their knowledge of heat to study specific heat and it's applications. In class, students will be learning about the heat transfer methods of radiation, conduction, and convection. To apply this to a real-world experience, students will use an island as a model to describe the heating and cooling of land and water by explaining how solar radiation affects the heating and cooling of continents and oceans. Students are expected to measure temperature changes in sand and water that have been exposed to a heat lamp for daytime and darkness for nighttime. They will use the idea of specific heat to analyze temperature data, and compare geographic regions that have large and small temperature changes. The students will do a formal lab write up for this investigation, including a one-page explanation for the temperature seen in one specific city to demonstrate their ability to apply this information. Module 10 Next, students must learn the basics of matter, including atomic structure and formation of compounds. To do this, students will use models, made from boards and marbles, to demonstrate their understanding of the structure of atoms by identifying the major subatomic particles, building a model of an atom, and identifying the changes in an atom. Then students use their models to identify pure substances and compounds. They do this with an introduction to chemical formulas and the periodic table. Students use their models to build simple models of compounds, write their chemical formulas, and explain the meaning of a chemical formula. Next students learn about valence electrons and chemical bonds. They will model electron arrangements to learn about energy levels, chemical bonds, and the difference between ionic and covalent bonds. This will allow students to develop a strong understanding of how the periodic table is built and the reasoning behind the arrangement of atoms. This activity will culminate with a periodic table game, in which students are competing to identify and classify various elements into groups of the periodic table. Lastly, students will use the models to balance chemical equations and classify chemical reactions. Using the chemical equation, students model simple chemical reactions and balance simple equations. Doing this will allow them to discover the law of conservation of mass. Once they have demonstrated their understanding using the models, they will conduct a fun experiment where

they combine copper (II) chloride and aluminum to witness a single replacement reaction. After seeing the exciting exothermic reaction, they will combine copper (II) sulfate with aluminum and notice there is no reaction. As a class, the students discuss what adding sodium chloride would do to the reaction and experiment with it. They will find that the sodium chloride acts as a catalyst needed to jump-start the reaction. Students are required to do a formal lab write up for this investigation including their balanced equations and observations. Module 11 Once they have grasped the basics of atoms and molecules, students can explore the quantum theory and nuclear reactions. Using the models again, students will explore quantum theory, how atoms produce light, and the electron's role in that. Students learn how elements produce light, to recognize the difference between an atom at its ground state and an excited state, and explain how electrons are involved in light absorption and emission. As a demonstration, the teacher performs the "electric pickle" demonstration showing excited electrons giving off light as photons. With this understanding, they progress to the concept of nuclear reactions. They investigate using the models to demonstrate the structure of stable and unstable atoms. Students will build models of stable and unstable atoms, model an ion, and calculate the charge of an ion. Using the models to study both quantum theory and nuclear reactions allows students to apply their prior knowledge of atomic structure to varieties and applications of atoms in reactions. Unit 5 – Electricity Module 12 The first part of this unit is about electric circuits, current and voltage, and resistance and Ohm's Law. The students will use the 2 light bulb circuits to discover what an electric circuit is. They will build a simple circuit, diagram it, explain how a switch works, identify open and closed circuits, and test conductors and insulators. Once they have built their circuits, students will analyze its voltage and current that they measure at different locations in and out of the circuit. They must calculate these values and present their results in a formal lab report, including a detailed diagram of the circuit they built and manipulated. To complete their lab work in this module, students will investigate the ideas of resistance and Ohm's Law. Students will explain the role of resistance in an electric circuit, measure resistance in ohms with a digital multimeter, and predict what happens when resistors are added in series to a light bulb circuit. This leads to an inquiry activity where students are challenged to answer the question: how are voltage, current, and resistance related? Students will do this by describing how current changes when resistance and voltage are increased and explaining why resistors are used in a circuit. Using a simple circuit will allow the students to build a strong foundation built of progressive discovery experiences with these concepts. Module 13 The second part of this unit is about series and parallel circuits, electrical power, capacitors, and AC and DC electricity. First, students learn about types of circuits they can build. They are expected to build, describe, and identify a series, parallel, and AND & OR circuits. Once they have experimented and built various circuits, they will have to analyze a circuit to explain why bulbs in a 2-bulb parallel circuit are brighter than ones in a 2-bulb series circuit. In order to do that, students must build series and parallel circuits, analyze the voltage and current and different places in the circuits, and explain why the bulbs wired in parallel are brighter than those in series. This is a critical experiment to help students prepare for the final portion of this unit where they are required to design and build a working circuit. They will use the engineering cycle to design a working prototype, test and refine a prototype, and describe energy transformations that occur in their circuits. This will demonstrate their mastery of electrical circuits and give them more practice with their engineering skills. Unit

6 – Electricity and Magnetism Module 14 To begin their study, students will complete investigations about magnets and magnetic materials. Starting with the basics, they will observe what happens when magnets are put next to each other. They should be able to predict whether two magnets with attract or repel given their alignment and measure the distance at which magnets attract and repel each other. Once they can do this, they will explore materials that are affected by magnets. Students will list examples of materials that are and are not affected by magnets. They will also measure the distance over which a magnetic field acts on magnetic objects and describe the effect of non-magnetic materials on magnetic forces. Next, students will use their understanding of electricity and magnets to build an electromagnet, in order to explore the concept that electric current creates a magnetic force and field. Students are expected to build an electromagnet, analyze how electric current affects the strength of the magnetic field in an electromagnet, and compare permanent magnets and electromagnets. All of these investigations are critical to complete and master, in order for students to be able to complete one of the big projects of this unit, where students build a working electric motor with magnets. Students are required to complete formal lab write-up for this investigation. Module 15 With their foundational understanding, students will progress to studying how motors work and building one on their own using magnets. First, they must understand how a motor works. Students will conduct an investigation to construct a working motor, use an electromagnet and explain how it reverses its north and south poles, and determine the direction a motor will spin given the orientation of its magnets. Once they have successfully built a motor, they will design motors for various tasks. Students will determine the proper placement of permanent magnets to make a motor run with each of the switching disks during the design process. Then they will evaluate all designs and come to a consensus, through scientific discourse, on which motor will serve the different required tasks best. Going through this process will allow them to understand how a motor works, how to design and build one, and, finally, how to analyze a motor for effectiveness in completing various tasks. After completion of these tasks, students will wrap up the unit with a look at energy generators and transformers, such as a wind turbine. Module 16 As the final part of the unit, students will be studying wind power, wind turbines, and how to generate electricity with it that is done in a safe, sustainable way. This lab module will have students learning how to generate electricity from the wind, how to design an efficient, working wind turbine, how human activity impacts the environment in positive and negative ways, what variables affect the movement of the blades on a wind turbine, and, finally, what variables effect the production of electric current in a wind turbine. Students will go through a process step-by-step where they will learn about the turbines, analyze and evaluate current or proposed turbines, and design and build a working wind turbine for themselves. It is important for students to look at human impacts on the environment and consider these factors when making their decisions. Also, seeing the effects of changing variables, such as blade shape, mass, kinetic energy, coil size, and the number of magnets present, will allow students to develop a strong mental model of how changes in wind turbine design can make their turbines more or less effective and efficient. This unit-culminating activity is one that will leave students with strong ties between their knowledge, engineering skills, and environment. Unit 7 – Vibrations, Waves, and Sounds Module 17 In the first part of this unit, students will be studying harmonic motion and the properties of oscillators. To do this, students will work with a pendulum to describe its motion, measure the

amplitude and period of it, and describe any oscillators in terms of frequency, period, amplitude, and phase. Further, they will learn to read and represent these things on a graph. The students will work with a pendulum, hung from a physics stand, that has varying masses attached, in order to see how all of the variables are related and change together. Once students have measured, manipulated, and graphed the variables of an oscillator in harmonic motion, they will explore what kinds of systems oscillate. Students will build a mechanical oscillator and find its period and natural frequency. Then they will change the natural frequency of that oscillator to further observe the changes and relationships within the system. As groups, they will work together to analyze a specific oscillator for its natural frequency and what various changes would do to the system. To apply their knowledge, students will look at harmonic motion in relation to skyscrapers in a lab activity with simulations. They will apply their understanding to describe important factors that must be considered when building tall skyscrapers. Then they will look at different designs of skyscrapers and analyze them for their safety and effectiveness in withstanding the environmental factors that affect all buildings of that size. As a group, they will design a skyscraper that has solutions to the problems that harmonic motion will cause to the building. Module 18 Once students understand harmonic motion and oscillators, they are prepared to study waves and their properties. To begin, students will investigate waves and their properties using a string over a small tube of colored water. By moving the string and causing it to vibrate, they will create waves in the water and can make observations about what they notice. They will explain how waves move, compare and contrast transverse and longitudinal waves, and use knowledge of these wave types to describe water waves. Next students will learn about the various waves that surround them on a regular basis. They will then investigate to discover how to make and control waves. Students will describe how frequency, wavelength, and speed are related by measuring the wavelength and frequency of a vibrating string. Experimenting will allow them to recognize and apply the concept of harmonics in resonant systems, and define natural frequency and apply methods for changing the natural frequency of a system. In a final investigation before studying sound, students will determine how changing the tension of a vibrating string affects it. They will apply an understanding of inertia and restoring force to describe the effects of increasing the tension of a vibrating string, explain how a string’s tension and mass affects its frequency and amplitude, and describe how wave properties are applicable to musical instruments. As an application, they will apply their understanding to the string on a guitar. Students are required to complete a formal lab report for this investigation. This will be a great transition topic for students as we move into the study of sound and their final project. Module 19 In order for students to build an instrument, they must understand the concepts of sound, hearing, and music. To reach this point, students will begin by investigating what sound is and how we hear it. They will identify a range of frequencies humans can hear, describe how perception influences the sound humans hear, and make and analyze a histogram of class data. Then students will experiment to determine whether sound behaves like other waves. To do this, students will listen to beats and explain how the presences of beats is evidence that sound is a wave. Also, they will create interference of sound waves and explain how it is also evidence of the wave nature of sound. Lastly, they will investigate how we observe sound as a wave and how we can use the speed of sound and certain frequencies to build a basic instrument based on wavelength. During this experiment, students will build palm pipes, in order to explain how

pitch is related to frequency and wavelength of a sound wave. They will determine the lengths of pipe required to produce sounds at certain frequencies at a specific speed of sound and construct a basic instrument from PVC pipe to play musical notes with. Although this will be a whole-class investigation, students will use this experience to produce their own individual instruments. They can be either a string or wind instrument. It must be different from the one we make as a class during class time. This will be the concluding experiment and project, which will require great application of all physics knowledge and skills gained in this unit and throughout the course.

*** Key Assignments**

Listed here are the key assignments to be given to the students throughout the school year. They will be collected, graded, and reviewed with the students, in order for them to really grasp the concepts that they aren't comprehending, yet don't know they haven't mastered it. Homework: Homework is assigned daily, with either problems from the textbook, skills and practice sheets for reinforcement, or preparation activities for lab investigations. Depending on how difficult the assignment is, it can range anywhere from one to three tasks with between 3 and 15 questions. Students will also complete guided reading activities, which include taking Cornell notes of the readings in the textbook. The purpose of these activities is to reinforce the readings, lessons, activities, and investigations we do in class. The students assess most daily homework, but the teacher will grade more complex assignments. Lab Investigations: Participation in all laboratory activities is critical in this course because of the emphasis that is put on it for concept mastery. Students are expected to follow all instructions, perform the investigations safely, and submit completed lab reports. They are required to complete at least one, if not two, formal lab reports for each unit of study and many more informal write-ups using teacher-made templates or worksheets. All lab reports, both formal and informal, include scientific practices of: hypothesizing, diagramming and writing procedures, collecting and analyzing data, and discussing results and conclusions. Additionally, some labs require additional attachments, such as free-body diagrams, models, or short writing assignments. These are scientific skills that are critical for all further science courses in high school and college. The formal reports must be typed, organized, and thorough. Physics News Updates – Students will be given a particular class period each semester to share a current news report based on a recent newsworthy topic in physics. Each student will be required to research the topic, write a one-page summary of the news and evidence it is based off of, and post all information on the news bulletin board in the classroom. This will encourage students to read science expository writings and give them an opportunity to explore the concept of source validity as it relates to science. Many students don't really understand the skewed results that scientists will produce to prove a point. This will be discussed and studied as the students present their topics. They will repeat this process in the second semester as well. Research Reports – Students will complete two research reports during the school year, which will include a written paper and short presentation. Unit 4 – Effects of Radiation on Humans – This research report will require students to research the effects of radiation on humans by considering the question: do the benefits outweigh the risks? This can cover a wide range of topics from radiology to the fallout from the atomic bomb dropped on Japan. The report must be 3-5 pages, typed, and double-spaced. It will be submitted during finals week when they give their

presentation of their findings. This presentation must include their results of their research, their opinion about the benefit to risk ratio, and discuss the validity of their sources of information. It must be 5-8 minutes in length, utilize technology, and will be given during the final week of class before the final exam of the first semester. Unit 6 – Human Impacts on the Environment - The second report accompanies their study of wind turbines and generating electricity from magnets, and will be part of the culminating activities for Unit 6. It will cover human impacts on the environment in various situations. Each student will view or read Dr. Seuss' book The Lorax and will have a class discussion about the human impacts of capitalism on the trees. This will guide student interest to choose a way humans are impacting the environment for their own gain. Students should consider what humans are doing the environment, what impact that is having on the local environment, and how it affects the world on a global scale. This must include a discussion on how it is impacting global warming, and how that in-turn affects humans. Once again, they should consider: do the benefits outweigh the risks? Students are required to share their research and findings in a 3-5 page, typed, and double-spaced paper. Then they will use time in class to present their finding to the rest of the class in a 5-8 minute presentation utilizing technology in some form. Group Projects – Throughout the year, the students will be completing group projects in Units 1, 2, 3, 5, and 7. They are described below: Unit 1 – Analyze a Collision – Students will work in groups to analyze a car crash mystery to figure out which car was at fault and what the conditions were like before and after the collision. They will use their ideas and experiences from their lab investigations to aid them in this. Each group is expected to work together to solve the mystery and provide initial and final velocities, including direction of motion, and initial and final momentums. To present their findings, they will create a video outside of class dramatizing their mystery and findings. The video must be between 5 and 10 minutes in length and will be shared in class. Unit 2 – Apply Gravitational Motion to Satellites – Students will apply their knowledge of gravitational motion to explain how and why a satellite stays in orbit. In a diagram model, students will create a poster that explains their understanding of the circular motion principles for satellites, mathematics of satellite motion, and demonstration of weightlessness in orbit. This diagram must contain an illustration, detailed description, and mathematical representation of the information. It will be shared briefly with the rest of a class in a short presentation during class. Unit 3 – Design a Rollercoaster – Students are required to design a rollercoaster using tubing and a marble. It must use the concept of energy transformation to transition well from potential to kinetic energy and back again. The challenge is to shape the tube in a rollercoaster track that will allow the marble to run the whole track without stopping or needing additional pushing. A poster showing a diagram with calculations of kinetic and potential energy at each crest, trough, and loop must accompany each rollercoaster. Students will be presenting their projects at the fall science fair at the school. They will be demonstrating the functions of their rollercoaster to parents, students, and teachers. Unit 5 – Design and Build an Electrical Circuit – The culminating activity and project of Unit 5 require students to design and build an electric circuit. They will use the engineering cycle to design a working prototype, test and refine a prototype, and describe energy transformations that occur in their circuits. This will demonstrate their mastery of electrical circuits and give them more practice with their engineering skills. Each group will create a poster to accompany their circuit describing the components, including calculated values for resistance, current, and voltage at various points within the

circuit. These circuits will be displayed during the spring open house at the school. Again, students will be presenting their circuits to parents, students, and teachers that visit our room during the event. Unit 7 – Design and Build a Musical Instrument – As the final project of the course, students will use their knowledge of vibrations, waves, and sound to design and build a musical instrument. It must be either a string or wind instrument using the concepts learned in the palm pipe construction lab, but the instrument must be different from the one made in class. Students will create the instrument and present their work in a technological way to their classmates. This can include PowerPoint presentations, videos, digital photo collages, etc. but must demonstrate the instruments ability as well. Students will submit the instruments and deliver their presentations during finals week of the second semester before the final exam.

*** Instructional Methods and/or Strategies**

A combination of instructional methods and strategies are used to ensure that the curriculum reaches all students, so that they may master the concepts presented in this course. Laboratory Investigations – The core of this class lies in the experimentation students do during laboratory investigations. Students spend up to half of the class time during a given week working on investigations. They will be completing teacher-guided, guided inquiry, and unguided inquiry experiments to answer questions about physical phenomena, in order to discover the laws and rules that govern our physical world. High-quality, technological equipment from CPO Science will be used to allow students to learn through several student-centered experiences that are engaging and effective. Students are expected to complete formal lab reports throughout the course. This demonstrates their knowledge of the concepts, but more importantly their ability to do science. They use the scientific method and traditional lab write-up format to show their scientific skills. The reports, which are completed at least once each unit, are expected to be typed, double-spaced, organized and neat. During investigations and projects focused on engineering and design, students use the engineering cycle to guide their work in designing and building their models and projects. Making laboratory work a central focus in the course allows students to gain a deeper knowledge of the concepts and science skills they will need in future science courses. Cornell Notes and Guided Readings – Cornell notes are used as a preview activity when students enter a new chapter, in order to introduce them to the vocabulary and important concepts they will be studying in that next section. This aids students who have limited English communication skills and all students in better understanding what they are reading in the textbook. The guided reading activities are to aid students as they do the majority of the textbook reading. They review and test students for comprehension as they go through each reading. It will help guide all students, but especially those that need the support with reading comprehension, focus, and academic language. Textbook Readings – The students are assigned to read important sections in the textbook and complete various homework activities to help them learn the concepts and test their understanding. Generally, these readings will follow an in-class activity or investigation that has already previewed the topic. This way, the textbook is an additional instructional support, not the main focus of the students' learning. The textbook used is rigorous but with an appropriate math requirement to meet the lower math level of the students. Supplemental Readings – Expository readings that cover specific topics and concepts from the curriculum are used in class in group and

individual work. They act as introductory or application activity to more advanced or difficult concept. The advanced students will work in assigned groups to help interpret the article with their group. Their leadership role challenges their ability and understanding. This interaction creates peer scaffolding and differentiation within these preview activities. From these readings, students will have arguments from evidence and discussions about the concepts from and sources of the reading. Source validity will be evaluated and discussed, in order for students to be more critical of the information they are reading. Group Discussion – Utilizing experiences from investigations, expository readings, and discussion questions, students work in groups to have discourse and conversations about important concepts or problems from the curriculum. This encourages students to initiate the discussions of any phenomena they encounter and to discuss how they are related to the subjects being studied. These can be student-led with their questions or teacher-led with a given question or topic. Effective communication about scientific ideas is an essential skill all students need to progress in their study of science. Videos – The instructor utilizes the textbook publisher, online, or instructor-made videos to further illustrate concepts from the course. They provide vivid demonstration of sometimes abstract and confusing topics. Students are able to access these videos on the class portal and watch them repeatedly, if needed for help. These will supplement the readings and homework assignments students have, in order to help make better sense of these difficult concepts. The videos provide scaffolding and differentiation, as students can watch them at their own pace for mastery. Research Project and Presentations – Another crucial science skill is the ability to research a topic and convey the results and information in written and oral format. Science is based in research and communication of ideas and evidence that supports them. As students learn to evaluate sources for validity and reliability, they will apply this to their research for the required projects each semester. The presentations allow students to develop confidence and experience with their ability to communicate their findings to their peers. PowerPoint Presentations – Teacher- and publisher-prepared PowerPoint presentations are used throughout the course to aid students in understanding what they are learning in the textbook. Many students struggle with reading comprehension of science textbooks because the material can be dense and use advanced academic language. To support their work and reading, the instructor uses PowerPoint presentations to better explain the topics in a way that is more relatable and understandable.

*** Assessment Methods and/or Tools**

The assessments listed below are given to each student to evaluate their mastery of the concepts/principles/laws of physics. There is a variety of assessment methods to gain the most accurate evaluation of student comprehension. All students are required to participate in the class discussions, investigations, and activities, as well as develop their ability to conduct research in both independent and collaborative tasks. Homework and Class Work – 20% of Final Grade Students are expect to do homework daily to reinforce ideas learned in class, which is collected at the end of the class period in which it is due. This is to give students time to ask questions of the instructor and peers. Allowing students to ask questions about difficult problems, gives the instructor a better understanding of what the students aren't understanding and need more remediation with. This category includes all practice problems, readings, current

news reports, guided readings, notes, expository readings, and lab preparation. Also, class work is included, which includes participation and demonstration of understanding from discussions, activities, and practice done in class. Students are expected to complete assignments on time will be given their graded work back, in order to allow them to correct mistakes to remediate the areas they need most help with. Projects – 20% of Final Grade Listed in the key assignment section, the projects in this class are done at least once each unit. These projects include written research papers, research presentations, and designing and building various models. Science is more than theoretical ideas; it is a set of physical concepts/principles/laws that govern the world we live in. Students complete projects to demonstrate their theoretical and experimental understanding of the key concepts in each unit. They will be analyzing, applying, researching, designing, and building different models and systems to illustrate the theoretical ideas they have been studying. These projects are both individual and collaborative efforts. Laboratory Investigations – 30% of Final Grade The students are required to do group laboratory investigations to build and develop their experimental skills. They are expected to following all instructions carefully, conduct safe procedures, and collect and analyze data. Students are expected to demonstrate their method and results in both informal and formal lab reports and write-ups. Within each unit, students will be completing multiple informal reports, and at least one formal report, as they work to complete the lab modules. Assessment is based upon participation, cooperation, safety, and completeness of the lab reports. Chapter Quizzes, Unit and Final Exams – 30% of Final Grade Beyond the assessment of daily work, lab, and projects, one of the main demonstrations of concept mastery is on the chapter, unit, and final examinations. Within each unit, students cover 2-4 chapters from the textbook. Students are expected to demonstrate their understanding and mastery on quizzes and exams at the end of each chapter, unit, and semester. These exams and quizzes are a combination of multiple choice, true/false, word problems, and essay prompts. The results will be discussed, reviewed, and corrected with the students.

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